JAPAN

EDICT OF GOVERNMENT

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JIS B 9920 (2002) (English): Classification of air cleanliness for cleanrooms

ISO INSIDE

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The citizens of a nation must honor the laws of the land.

Fukuzawa Yukichi

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JIS

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JIS B 9920 : 2002

(JACA/JSA)

Classification of air cleanliness for cleanrooms

ICS 13.040.35

Reference number : JIS B 9920 : 2002 (E)

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee, as the result of proposal for revision of Japanese Industrial Standard submitted by the Japan Air Cleaning Association (JACA)/the Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently **JIS B 9920** : 1989 is replaced with this Standard.

This revision has been made based on **ISO 14644-1** : 1999 *Cleanrooms and associated controlled environments—Part 1 : Classification of air cleanliness* for the purposes of making easy to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of International Standard which is based on Japanese Industrial Standard.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

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In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

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Classification of air cleanliness for cleanrooms

Introduction This Japanese Industrial Standard has been prepared based on **ISO 14644-1** *Cleanrooms and associated controlled environments—Part 1 : Classification of air cleanliness* published in 1999 as the first edition with modification in technical contents.

In addition, portions underlined with dots are the matters which are modified the corresponding International Standard. A list of modification with its explanation is shown in Annex 1.

1 Scope This Standard specifies the classification of air cleanliness in cleanrooms and associated controlled environments (hereafter referred to as "cleanroom facilities") exclusively in terms of concentration of airborne particles, and its evaluation method. Only particle populations having cumulative distributions based on threshold (lower limit) sizes ranging from 0.1 μm to 5 μm are considered for classification purposes. However, concentrations of ultrafine particles (particles smaller than 0.1 μm) and macroparticles (particles larger than 5 μm) may be used to quantify these populations in terms of U descriptors and M descriptors, respectively.

This classification shall not be used in order to characterize a physical and chemical nature of airborne particles. Furthermore, the relation between the particle size and maximum permitted concentration specified in this Standard are intended for classifying, and do not express the actual particle size distribution.

Remarks : The corresponding International Standard of this Standard shall be as follows:

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

ISO 14644-1 : 1999 *Cleanrooms and associated controlled environments—Part 1 : Classification of air cleanliness* (MOD)

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards (including amendments) shall be applied.

JIS B 9921 *Light scattering automatic particle counter*

JIS Z 8101-1 *Statistics—Vocabulary and symbols—Part 1 : Probability and general statistical terms*

JIS Z 8122 *Contamination control—Terminology*

3 Definitions For the purposes of this Standard, the definitions given in **JIS Z 8122**, **JIS B 9921** and **JIS Z 8101-1**, and the following definitions apply.

3.1 General

3.1.1 classification of air cleanliness Level of airborne particulate cleanliness applicable to a cleanroom expressed in terms of Class N, which represents maximum allowable concentrations (in particles per 1 m^3 of air) for considered sizes of particles.

Remarks 1 Level of airborne particulate cleanliness shall be designated by N according to the formula (1) of **4.2**, and shall be expressed by Class N.

2 Classification in accordance with this Standard is limited to the range extending from Class 1 through Class 9.

3 Intermediate class may be used as the level of airborne particulate cleanliness with 0.1 the smallest permitted increment; i.e. the range of intermediate classes extends from Class 1.1 through Class 8.9.

4 Classification may be specified in any of three occupancy states of cleanrooms, as-built, at-rest and operational (see **3.4**).

3.2 Airborne particle

3.2.1 particle size Diameter of a sphere that produces a response, by a given particle-sizing instrument, that is equivalent to the response produced by the particle being measured.

Remarks : For discrete-particle-counting, light-scattering instruments, the equivalent optical diameter is used.

3.2.2 particle size distribution Cumulative distribution of particle concentration as a function of particle size.

3.2.3 ultrafine particle Particle with an equivalent diameter less than 0.1 μm.

3.2.4 macroparticle Particle with an equivalent diameter greater than 5 μm.

3.2.5 fibre Particle having an aspect (length-to-width) ratio of 10 or more.

3.3 Descriptors

3.3.1 U descriptor Measured or specified concentration, of particles per 1 m^3 of air, including the ultrafine particles.

3.3.2 M descriptor Measured or specified concentration of macroparticles per 1 m^3 of air.

3.4 Occupancy states

3.4.1 as-built Condition where the installation is complete with all services connected and cleanroom facilities operated but with no production equipment, instruments, or personnel present.

3.4.2 at-rest Condition where the installation is complete with cleanroom facilities operated, equipment for production installed and operating in a manner agreed upon by the customer and supplier, but with no personnel present.

3.4.3 operational Condition where the installation is functioning in the specified manner, with the specified number of personnel present and working in the manner agreed upon.

3.5 Others

3.5.1 95 % upper confidence limit (UCL) Concentration values obtained by estimating the concentration of a population by 5 % of significance level using Student's t distribution from the average and standard deviation of the measuring particle concentration in the space of cleanroom facility. It is used for the case of sampling locations from 2 to 9.

3.5.2 average particle concentration at location Average particle concentration for a certain period of time at a sampling location.

3.5.3 over all mean of average particle concentration at location Average in a space of the average particle concentration for a certain period of time at a sampling location.

3.5.4 sequential sampling air cleanliness evaluation method Method for determining classification of air cleanliness if it is suitable or not by comparing with the reference value expected from the observed cumulative particle number and the sample volume by the continuous instrumentation at each sampling location. It is applicable to the space which is Class 4 of air cleanliness or cleaner.

3.5.5 reference value for upper limit Particle number shown in the formula (E.1) which is used in the sequential sampling air cleanliness evaluation method. It is used for determination of non-acceptance.

3.5.6 reference value for lower limit Particle number shown in the formula (E.2) which is used in the sequential sampling air cleanliness evaluation method. It is used for determination of acceptance.

3.5.7 expected cumulative particle count The expected value of particle count calculated from the maximum permitted concentration, the cumulative sample volume shown in the formula (E.3), which are used in the sequential sampling air cleanliness evaluation method.

3.5.8 observed cumulative particle count Cumulative particle count of measured values, which is used in the sequential sampling air cleanliness evaluation method.

4 Classification of air cleanliness

4.1 Occupancy state(s) The particulate cleanliness of air in a cleanroom shall be defined in one or more of three occupancy states, viz. "as-built", "at-rest", or "operational" (see **3.4**).

4.2 Classification number Airborne particulate cleanliness shall be designated by a classification number, N. The maximum permitted concentration of particles, C_n, for each considered particle size, D, is determined from the formula:

$$C_n = 10^N \times \left(\frac{0.1}{D}\right)^{2.08} \quad \text{..... (1)}$$

where, C_n : the maximum permitted concentration (in particles per 1 m³ of air) of airborne particles that are equal to or larger than the considered particle size, D.

C_n is rounded to the nearest whole number, using no more than three significant figures.

N : the classification number, which shall be a value from 1 to 9. Intermediate classification numbers may be a value from 1.1 to 8.9.

D : the considered particle size (μm)

0.1 : a constant (μm)

Table 1 presents classification of air cleanliness and the maximum permitted concentration for each measuring particle size. Fig. A.1 provides a representation of Table 1 in graphical form. In the case of intermediate class and measuring particle size, the maximum permitted concentration, C_n shall be according to the formula (1).

Table 1 Classification of air cleanliness

Classification of air cleanliness (N)	Maximum permitted concentration (particles/m³)					
	Measuring particle size					
	0.1 μm	0.2 μm	0.3 μm	0.5 μm	1 μm	5 μm
Class 1	10	2				
Class 2	100	24	10	4		
Class 3	1 000	237	102	35	8	
Class 4	10 000	2 370	1 020	352	83	
Class 5	100 000	23 700	10 200	3 520	832	29
Class 6	1 000 000	237 000	102 000	35 200	8 320	293
Class 7				352 000	83 200	2 930
Class 8				3 520 000	832 000	29 300
Class 9				35 200 000	8 320 000	293 000

Remarks : Uncertainties related to the measurement process require that concentration data with no more than three significant figures be used in determining the classification level.

4.3 Designation of specification regarding air cleanliness The designation of airborne particulate cleanliness for cleanrooms shall include:

a) the classification number, expressed as "Class *N*";

b) the occupancy state;

c) the considered particle size(s), and its maximum permitted concentration.

Example : Class 4; operational state; 0.2 μm (2 370 particles/m^3), 1 μm (83 particles/m^3)

The considered particle size(s) shall be agreed upon by the customer and the supplier.

If measurements are to be made at more than one considered particle size, each larger particle diameter shall be at least 1.5 times the next smaller particle diameter.

Example : $D_2 \geqq 1.5 \times D_1$

where, D_1, D_2 : considered particle size

5 Demonstration of compliance with air cleanliness

5.1 Principle Compliance with air cleanliness (classification of air cleanliness) requirements specified by the customer is verified by performing specified testing procedures and by providing specified documentation of the results and conditions of testing, as agreed upon by the customer and the supplier.

5.2 Testing The evaluation method for demonstrating compliance shall be as given in Annex B. An alternative method having comparable accuracy may be specified, although if no method is specified or agreed upon, the reference test method shall be used. However, for the evaluation of classification of air cleanliness which is cleaner from Class 4, the sequential sampling shown in Annex E may be applicable.

Tests performed to demonstrate compliance shall be conducted using calibrated instruments.

5.3 Maximum permitted concentration of airborne particles Upon completion of testing in accordance with the method of Annex B, average particle concentrations and the 95 % upper confidence limit (when applicable) shall be calculated using formulae shown in Annex C. Average particle concentration(s), calculated in accordance with formula (C.1) of Annex C, shall not exceed the maximum permitted concentration determined by use of formula (1) in **4.2**, for the considered size(s) agreed upon in **4.3 c**). Furthermore, for situations in which the number of sampling locations involved is at least two but not more than nine, the calculation of 95 % upper confidence limits in accordance with (C.3) of Annex C shall not exceed the maximum permitted concentration.

In the case of completion of test performed in accordance with the method of Annex E, the maximum permitted concentration shall not be exceeded at every sampling location.

When the number of considered particle size is more than one, the particle concentration for determination of classification shall be measured by the same method.

5.4 Test report The results from testing cleanroom facilities shall be recorded and submitted as a comprehensive report, along with a statement of compliance or noncompliance with the specified designation of airborne particulate cleanliness classification. The test report shall include the following:

a) the name and address of the testing organization, and the date on which the test was performed;

b) the numbers and years of publication of **JIS** and **ISO**;

Example : **JIS B 9920** : 2002 [**ISO 14644-1** : 1999 (E)]

c) a clear identification of the physical location of the cleanroom facility tested (including reference to adjacent areas if necessary), and specific designations for coordinates of all sampling locations;

d) the specified designation criteria for the cleanroom facility, including the classification of air cleanliness, the relevant occupancy state(s), and the considered particle size(s);

e) details of the test method used, with any special conditions relating to the test or departures from the test method, and identification of the test instrument and its current calibration certificate;

f) the test results, including particle concentration data for all sampling location coordinates.

Remarks : If concentrations of ultrafine particles or macroparticles are quantified, as described in Annex D, the pertinent information should be included with the test report.

6 Particle measuring test and test frequency In order to assure the classification of air cleanliness of airborne particles, it is necessary to test a cleanroom facility periodically. Test conditions shall be as shown in Table 2.

Table 2 Particle measuring test and test frequency

Classification of air cleanliness	Maximum test interval	Test method
Cleaner than Class 5	6 months	Annex B
Exceeding Class 5	12 months	Annex B

Remarks 1 The particle measuring test shall be usually performed in the operational state of cleanroom facility. Furthermore, according to the specified classification of air cleanliness, it may be performed in the at-rest state.

2 When monitoring the particle concentration of airborne particles and the air pressure difference continuously or frequently (within 60 min) in the cleanroom facility, the maximum test interval may be extended upon deliberation. In this case, it is necessary to record the result of monitoring which shows the range within the specified range and to keep it.

Annex A (informative)

Graphical illustration of the classes of Table 1

Fig. A.1 depicts the classification of air cleanliness shown in Table 1 of the body of the text in graphical form, for illustration purposes only. The classes of Table 1 are shown as lines representing the maximum permitted concentration for the considered threshold particle sizes. They are based on calculations using formula (1) of **4.2**. As the lines only approximate the maximum permitted concentration, they are not to be used to define the upper limits. The classification lines shown on the graph may not be extrapolated beyond the solid circle symbols, which indicate the minimum and maximum particle size limits acceptable for each of the classes shown. The classification lines do not represent actual particle size distributions found in cleanroom facilities.

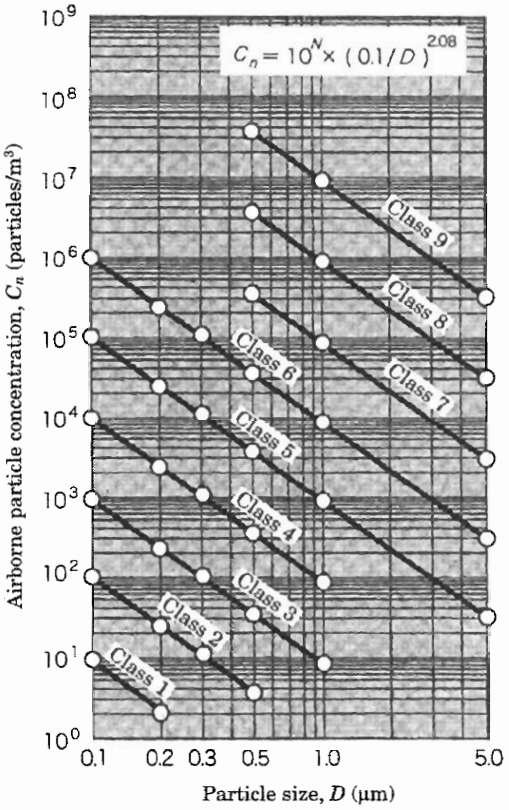

Fig. A.1 Graphical representation of maximum permitted concentration for classification of air cleanliness

Annex B (normative)

Determination of particulate cleanliness classification using a discrete-particle-counting, light-scattering instrument

B.1 Principle A discrete-particle-counting, light-scattering instrument is used to determine the concentration of airborne particles, equal to and larger than the considered particle sizes, at designated sampling locations. It shall be capable of counting the individual airborne particle by particle size.

B.2 Apparatus requirements

B.2.1 Particle-counting instrument The particle-counting instrument shall have a means of displaying or recording the count and size of discrete particles in air with a size discrimination capability to detect the total particle concentration in the appropriate particle size ranges for the class under consideration, and a suitable sampling system. In principle, the discrete-particle-counting, light-scattering instrument (which refers to the light scattering automatic particle counter specified in **JIS B 9921**) shall be used.

B.2.2 Instrument calibration The instrument shall have a valid calibration certificate; the frequency and method of calibration should be based on current accepted practice.

B.3 Pretest conditions

B.3.1 Preparation for testing Prior to testing air cleanliness, verify that all aspects of the cleanroom facilities that contribute to its operational integrity are complete and functioning in accordance with its performance specification.

Such pretesting may include, for example:

a) airflow volume or velocity tests;

b) air pressure difference test;

c) containment leakage test;

d) installed filter leakage test.

The items of pretesting which specify the test frequency shall be as agreed upon by the customer and supplier. Generally, they shall be as shown in Table B.1.

Table B.1 Items and frequency of pretesting

Items of pretesting	Maximum test interval
Airflow volume or velocity tests (1)	12 months
Air pressure difference test (2)	12 months

Notes (1) The airflow volume is obtained by the measurement method for airflow velocity or airflow rate.

(2) This test does not apply to the cleaning section of space not closed wholly.

Remarks 1 These tests shall be usually performed in the operational state or in the at-rest state according to the specified classification of air cleanliness.

2 When monitoring the particle concentration of airborne particles and the air pressure difference continuously or frequently (within 60 min) in the cleanroom facility which requires pretesting, the maximum test interval may be extended upon deliberation. In this case, it is necessary to record the result of monitoring which shows the range within the specified range and to keep it.

B.3.2 Pretest equipment setup Perform equipment setup and pretest calibration of the instrument in accordance with the manufacturer's instructions.

B.4 Sampling

B.4.1 Establishment of sampling locations Derive the minimum number of sampling locations from the following formula (B.1).

$$N_L = \sqrt{A} \quad \cdots\cdots (B.1)$$

where, N_L : the minimum number of sampling locations (rounded up to a whole number)

A : the area of the cleanroom facility (m^2)

Remarks 1 In the case of unidirectional horizontal airflow, the area A may be considered as the cross section of the moving air perpendicular to the direction of the airflow.

Ensure that the sampling locations are evenly distributed throughout the area of the cleanroom facility and positioned at the height of the work activity.

If the customer specifies additional sampling locations, their number and positions shall also be documented upon deliberation.

2 Such additional sampling locations may be those considered critical, based on a risk analysis.

B.4.2 Establishment of single sample volume per location The single sample volume at each sampling location shall be the minimum single sample volume V_s determined by using the formula (B.2) or more, and the sampling time shall be at least 1 min, and the sample volume shall be at least 2×10^{-3} m³.

$$V_s = 1\,000 \times 20/C_{n,m} \quad \text{(B.2)}$$

where, V_s : the minimum single sample volume at sampling location (10^{-3} m³)

$C_{n,m}$: the class limit (particles/m³) for the largest considered particle size specified for the relevant class

20 : the defined number of particles that could be counted if the particle concentration were at the class limit

Remarks 1 When the particle concentration of the largest particle size among the considered particle sizes at each sampling location is at the upper limit of the selected classification of air cleanliness, V_s is the air volume where it is estimated that 20 particles which are the minimum number of particle are detected.

2 When V_s is very large, the time required for sampling can be substantial. By using the sequential sampling air cleanliness evaluation method (see Annex E), both the required sample volume and the time required to obtain samples may be reduced.

B.4.3 Sampling procedure

B.4.3.1 Set up the particle counter (**B.2.1**) in accordance with the manufacturer's instructions and in compliance with the instrument calibration certificate.

B.4.3.2 The sampling probe shall be positioned pointing into the airflow. If the direction of the airflow being sampled is not controlled or predictable (e.g., nonunidirectional airflow), the inlet of the sampling probe shall be directed vertically upward.

B.4.3.3 Sample the volume of air determined in **B.4.2**, as a minimum, at each sampling location.

B.4.3.4 Where only one sampling location is required in **B.4.1**, take a minimum of three single volumes at that location.

B.5 Recording of results

B.5.1 Average concentration of particles at each sampling location

B.5.1.1 Record the result of each sample measurement as the concentration of each of the considered particle size(s) appropriate to the relevant classification of air cleanliness according to **3.3** of the body of the text.

Remarks : Consideration should be given to the requirements of **B.6.1** before proceeding with the calculation of the 95 % upper confidence limit.

B.5.1.2 When only one sampling location is used, calculate and record the average value of the sample data for each considered particle size.

B.5.1.3 When two or more single sample volumes are taken at a sampling location, compute the average particle concentration for each considered particle size from the individual sample particle concentrations (**B.5.1.1**), according to the procedure given in **C.2** of Annex C.

B.5.2 Requirement for computing the 95 % upper confidence limit (UCL)

B.5.2.1 When the number of sampling locations is more than one and less than ten, compute the overall mean of the averages, standard deviation, and 95 % upper confidence limit from the average particle concentrations for all sampling locations (**B.5.1**) following the procedure described in **C.3** of Annex C.

B.5.2.2 When only a sampling location is sampled, or when more than nine are sampled, computing the 95 % upper confidence limit is not applicable.

B.6 Interpretation of results

B.6.1 Classification requirements The cleanroom facility is deemed to have met the specified air cleanliness classification if the averages of the particle concentrations measured at each of the locations and, when applicable, the 95 % upper confidence limit calculated according to **B.5.2**, do not exceed the upper limits determined in **4.2**.

If the results of testing fail to meet the specified air cleanliness classification, testing may be performed at additional, evenly distributed sampling locations. The results of recalculation, including data from the added sampling locations, shall be definitive.

B.6.2 Treatment of outliers The result of the 95 % UCL calculation may fail to meet the specified upper limit of air cleanliness classification. If the noncompliance is caused by a single unusually high particle concentration resulting from an erroneous measurement (due to procedural error or equipment malfunction) or by an unusually low particle concentration (due to exceptionally clean air), the outlier may be excluded from the calculation, provided that:

a) the calculation is repeated, including all remaining sampling locations;

b) at least three measurement values remain in the calculation;

c) no more than one measurement value is excluded from the calculation;

d) the suspected cause of the erroneous measurement or low particle concentration is documented and accepted by both the customer and supplier.

Annex C (normative)

Statistical treatment of particle concentration data

C.1 Scope This statistical analysis considers only random errors (lack of precision), not errors of a nonrandom nature (e.g. bias associated with erroneous calibration).

C.2 Algorithm for computation of average particle concentration at a location ($\overline{x_i}$) When multiple samples are taken at a location, formula (C.1) shall be used to determine the average particle concentration at the location. Calculation of the average particle concentration shall be performed for each sampling location at which two or more samples have been taken.

$$\overline{x_i} = \frac{x_{i,1} + x_{i,2} + \Lambda + x_{i,n}}{n} \quad \text{..... (C.1)}$$

where, $\overline{x_i}$: the average particle concentration at location i

$x_{i,1}$ to $x_{i,n}$: the particle concentrations of the individual samples at location i

n : the number of samples taken at location i

C.3 Algorithms for computation of 95 % upper confidence limit

C.3.1 Principle This procedure is applicable only if the number of sampling locations is more than one and less than ten. In such circumstances, this procedure shall be used in addition to the algorithm of formula (C.1).

C.3.2 Determination of overall mean of the location averages ($\overline{\overline{x}}$) Using formula (C.2), determine the overall mean of the location averages.

$$\overline{\overline{x}} = \frac{(\overline{x_1} + \overline{x_2} + \Lambda + \overline{x_m})}{m} \quad \text{..... (C.2)}$$

where, $\overline{\overline{x}}$: the overall mean of the location averages

$\overline{x_1}$ to $\overline{x_m}$: individual location averages, determined by using formula (C.1)

m : the number of individual location averages

All individual location averages are equally weighted, regardless of the number of samples taken at any given location.

C.3.3 Determination of standard deviation of the location averages Using formula (C.3), determine the standard deviation of the location averages.

$$s = \sqrt{\frac{(\overline{x_1} - \overline{\overline{x}})^2 + (\overline{x_2} - \overline{\overline{x}})^2 + \Lambda + (\overline{x_m} - \overline{\overline{x}})^2}{(m-1)}} \quad \text{..... (C.3)}$$

where, s : the standard deviation of the location averages

C.3.4 Determination of 95 % upper confidence limit (UCL) for the overall mean Using formula (C.4), determine the 95 % upper confidence limit (UCL).

$$95\ \%\mathrm{UCL} = \bar{\bar{x}} + t_{(m-1,0.95)}\left(\frac{s}{\sqrt{m}}\right) \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (C.4)$$

where, $t_{(m-1,0.95)}$: quantile for 95 % upper confidence limit

Quantile $t_{(m-1,0.95)}$ for 95 % upper confidence limit shall be as given in Table C.1 based on the Student's t distribution.

Table C.1 Quantile for 95 % upper confidence limit

Number of individual averages (m)	2	3	4	5	6	7 to 9
$t_{(m-1,0.95)}$	6.3	2.9	2.4	2.1	2.0	1.9

Annex D (informative)

Considerations for the counting and sizing of particles outside the size range applicable for classification

D.1 Basic principle If the considered particle size range is smaller than 0.1 μm or larger than 5 μm, the classification of air cleanliness by U descriptors or M descriptors may be used as necessary. The maximum permitted concentration of such particles and the choice of test method to verify compliance are matters for agreement between the customer and the supplier.

D.2 Ultrafine particles smaller than 0.1 μm—U descriptor

D.2.1 Application When measuring the ultrafine particles which are smaller than 0.1 μm in the considered particle size, it is necessary to use the appropriate sampling devices and measurement procedures.

The minimum number of sampling locations should be determined in accordance with **B.4.1** and the minimum sample volume V_s should be 2 litres (**B.4.2**).

D.2.2 U descriptor format The ultrafine particle concentration of the U descriptor may be used alone or as a supplement to the airborne particulate cleanliness class. The U descriptor is expressed in the following format.

U (x ; y)

where, x : the maximum permitted concentration of ultrafine particles (particles/m^3)

y : the measured minimum particle size (50 % counting efficiency) (μm)

Example : U (140 000 ; 0.01 μm): Expresses a maximum permitted ultrafine particle concentration of 140 000 particles/m^3 in the particle size range ≧ 0.01 μm.

D.3 Macroparticles larger than 5 μm—M descriptor

D.3.1 Application When measuring the macroparticles which are larger than 5 μm in the considered particle size, it is necessary to use the appropriate sampling devices and measurement procedures. In the case of macroparticles, the factors such as the density, shape, volume and aerodynamic behaviour of the particles need to be taken into account. Also, for the macroparticles, it may be necessary to put special emphasis on specific components such as fibres.

D.3.2 M descriptor format The macroparticle concentration of the M descriptor may be used alone or as a supplement to the airborne particulate cleanliness class. The M descriptor is expressed in the following format.

M (a ; b) ; c

where, a : the maximum permitted concentration of macroparticles (particles/m^3)

b : the measured considered particle size (equivalent diameter) (μm)

c : the measurement method

Remarks : In the case of fibres, the format is expressed as "$M_{fibre}(a;b);c$".

Example 1 M (10 000; > 5 μm); time-of-flight aerosol particle counter: Expresses a macroparticle concentration of 10 000 particles/m^3 in the particle size range of > 5 μm, based on the use of a time-of-flight aerosol particle counter.

Example 2 M (1 000; 10 μm to 20 μm); cascade impactor followed by microscopic sizing and counting: Expresses a macroparticle concentration of 1 000 particles/m^3 in the particle size range of 10 μm to 20 μm, based on the use of a cascade impactor followed by microscopic sizing and counting.

Annex E (normative)

Sequential sampling air cleanliness evaluation method

E.1 Scope The sequential sampling air cleanliness evaluation method may be applicable when the classification of air cleanliness to evaluate is Class 4 or cleaner.

E.2 Evaluation method

E.2.1 Reference values The sequential sampling air cleanliness evaluation method shall be performed based on comparison of the observed cumulative particle counts to the reference count values expected from the sample volume.

Reference values which express the upper limit and lower limit shall be determined by the following formulae (see Fig. E.1).

The cumulative particle counts expected from the sample volume shall be calculated according to the formula (E.3).

$$C_H = 3.96 + 1.03E \quad \text{(E.1)}$$

$$C_L = -3.96 + 1.03E \quad \text{(E.2)}$$

$$E = V \cdot t \cdot C_n \quad \text{(E.3)}$$

where, C_H : reference values for upper limit (particles)

C_L : reference values for lower limit (particles)

E : the cumulative particle counts expected from the sample volume

V : sample volume rate (m^3/s)

t : sampling time (s)

C_n : the maximum permitted concentration of airborne particles (particles/m^3)

E.2.2 Determination method by Fig. E.1 Plot the observed cumulative particle counts and the expected cumulative particle counts in Fig. E.1, and continue to measure until the following conditions are satisfied, and determine.

a) When the observed cumulative particle counts are smaller than the reference value for lower limit, consider that the sampled air satisfies the specified classification of air cleanliness or the concentration limit, and let sampling be completed at that time.

b) When the observed cumulative particle counts are larger than the reference value for upper limit or 20, consider that the sampled air does not satisfy the specified classification of air cleanliness or the concentration limit, and let sampling be completed at that time.

c) As long as the observed cumulative particle counts are between the upper limit and the lower limit, sampling is allowed to continue until the expected cumulative particle counts become 20.

d) In the case of the observed cumulative particle counts of 20 or less at the time when the cumulative particle counts to be expected become 20, consider that the sampled air satisfies the specified classification of air cleanliness or the concentration limit.

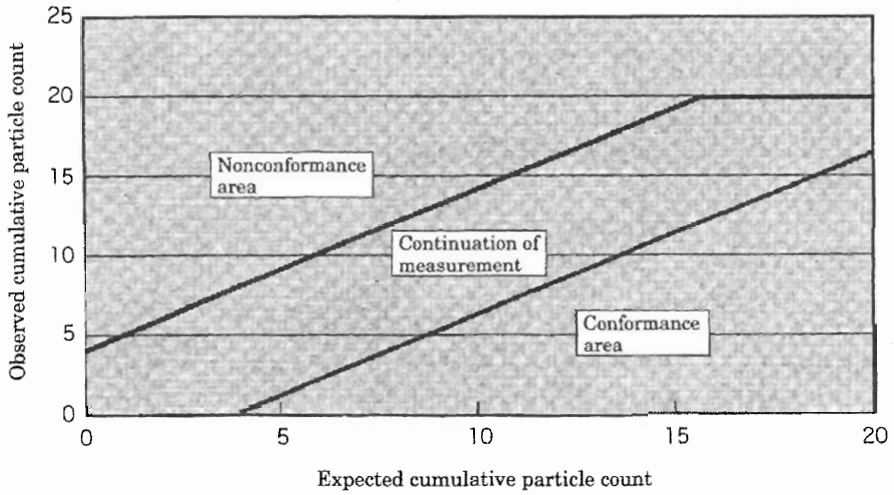

Fig. E.1 Boundaries for pass or fail by the sequential sampling method

Annex 1 (informative)

Comparison table between JIS and corresponding International Standard

JIS B 9920: 2002 *Classification of air cleanliness for cleanrooms*					**ISO 14644-1**: 1999 *Cleanrooms and associated controlled environments—Part 1: Classification of air cleanliness*		
(I) Requirements in **JIS**		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard by clause Location of deviation: text, annex Indication method: dotted underlines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
1	Scope	**ISO 14644-1**	1	Scope	IDT		
2	Normative references				MOD/ addition		Referred **JIS**s are added.
3	Definitions		2	Definitions	IDT		
3.1	General		2.1	General	IDT		
			2.1.1	cleanroom	MOD/ deletion		The content is included in **JIS Z 8122**.
			2.1.2	clean zone	MOD/ deletion		The content is included in **JIS Z 8122**.
			2.1.3	installation	MOD/ deletion		The content is included in **JIS Z 8122**.
3.1.1	classification of air cleanliness		2.1.4	classification	IDT		

(I) Requirements in **JIS**		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard by clause Location of deviation: text, annex Indication method: dotted underlines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
3.2	Airborne particle		2.2	Airborne particles	IDT		
			2.2.1	particle	MOD/ deletion		The content is included in **JIS Z 8122**.
3.2.1	particle size		2.2.2	particle size	IDT		
			2.2.3	particle concentration	MOD/ deletion		The content is included in **JIS Z 8122**.
3.2.2	particle size distribution		2.2.4	particle size distribution	IDT		
3.2.3	ultrafine particle		2.2.5	ultrafine particle	IDT		
3.2.4	macroparticle		2.2.6	macroparticle	IDT		
3.2.5	fibre		2.2.7	fibre	IDT		
3.3	Descriptors		2.3	Descriptors	IDT		
3.4	Occupancy states		2.4	Occupancy states	IDT		
			2.5	Roles	MOD/ deletion		The content is included in **JIS Z 8122**.
3.5	Others				MOD/ addition		Because Annex E became normative in this revision, this subclause is added.
4	Classification of air cleanliness		3	Classification	IDT		

(I) Requirements in **JIS**		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard by clause Location of deviation: text, annex Indication method: dotted underlines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
5	Demonstration of compliance with air cleanliness		4	Demonstration of compliance	MOD/ selection		Annex E (normative) was specified.
6	Particle measuring test and test frequency				MOD/ addition		Since it is necessary to specify the particle measurement test and test frequency in order to maintain and control cleanrooms, the content in **4.2** of **ISO 14644-2** was added.
Annex A (informative)	Graphical illustration of the classes of Table 1		Annex A (informative)	Graphical illustration of the classes of Table 1	IDT		
Annex B (normative)	Determination of particulate cleanliness classification using a discrete-particle-counting, light-scattering instrument		Annex B (normative)	Determination of particulate cleanliness classification using a discrete-particle-counting, light-scattering instrument	MOD/ addition		Since when pretesting it is necessary to specify the item and frequency of pretest, the content in **4.2** of **ISO 14644-2** was added.
Annex C (normative)	Statistical treatment of particle concentration data		Annex C (normative)	Statistical treatment of particle concentration data	IDT		
			Annex D (informative)	Worked examples of classification calculations	MOD/ deletion		Since the example of calculation is not specially needed for establishing standard, it was deleted.

(I) Requirements in **JIS**		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard by clause Location of deviation: text, annex Indication method: dotted underlines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
Annex D (informative)	Considerations for the counting and sizing of particles outside the size range applicable for classification		Annex E (informative)	Considerations for the counting and sizing of particles outside the size range applicable for classification	IDT		
Annex E (normative)	Sequential sampling air cleanliness evaluation method		Annex F (informative)	Sequential sampling procedure	MOD/ alteration		The sequential sampling method is specified as the evaluation method in **JIS B 9920** : 1989, and in order to maintain consistency with this specification, Annex was made not to be informative but to be normative.

Designated degree of correspondence between **JIS** and International Standard: MOD

Remarks 1 Symbols in sub-columns of classification by clause in the above table indicate as follows:

— IDT: Identical in technical contents.

— MOD/deletion: Deletes specification item(s) or content(s) of International Standard.

— MOD/addition: Adds specification item(s) or content(s) not included in International Standard.

— MOD/alteration: Alters the specification content(s) included in International Standard.

— MOD/selection: Parallel requirement(s) for specification content(s).

2 Symbol in column of designated degree of correspondence between **JIS** and International Standard in the above table indicates as follows:

— MOD: Modifies International Standard.

Errata for JIS (English edition) are printed in *Standardization Journal*, published monthly by the Japanese Standards Association, and also provided to subscribers of JIS (English edition) in *Monthly Information*.

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